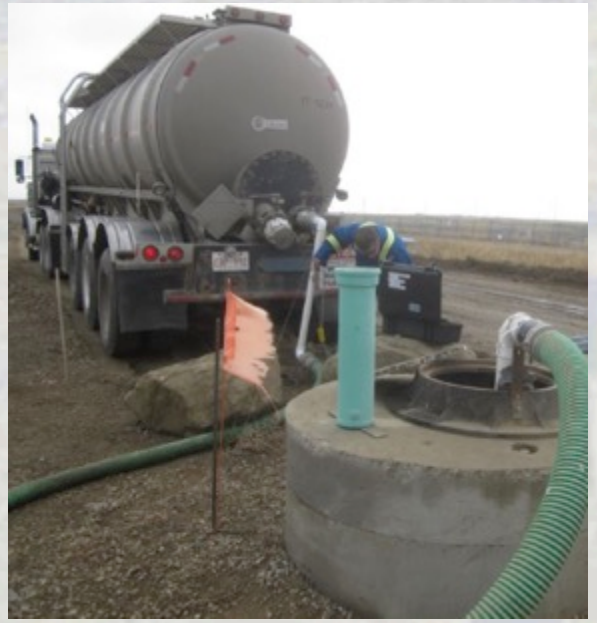
Growing Plants Using Treated Leachate Water

Project Location: East Calgary Waste Management Facility, City of Calgary

By: Owrang Kashef, P. Eng.
CH2M HILL Canada Limited
April 26th, 2016
SUSTREM 2016

Background

- In the late 1990s, the City of Calgary (the City) began managing leachate from its East Calgary Waste Management Facility (WMF) by collecting it and trucking it to the municipal wastewater treatment plant (WWTP)
- Leachate contains a wide array of contaminants:
  - Dissolved solids,
  - Heavy metals
  - Organic compounds



Background (continued)

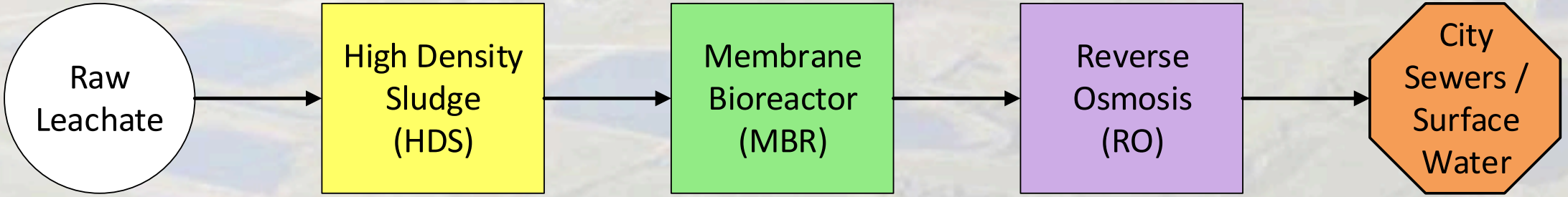
- Landfill leachate BOD concentration:
  - More than 10 times that of municipal waste water (300 mg/L)
- City's concern in discharging to WWTP
  - Stress the treatment system
  - Supersede discharge standards
- The City's Waste & Recycling Services (W&RS) began investigating options to treat the leachate before discharging it sewers

Background (continued)

- Leachate treatment technology evaluation
  - CH2M was retained by the City to develop a treatment process that could achieve compliance with City's Sewer Bylaw requirements
- Bench-scale testing:
  - CH2M design and completed bench-scale tests to evaluate treatment requirements and support treatment technology selection
- Bench test results:
  - Determined multiple technologies are required to achieve treatment requirements
- Field-scale pilot test:
  - Design a long-term pilot study to evaluate selected technologies

Treatment Process Overview

- Conceptual/preliminary design of pilot plant:
  - The treatment process consisted of three integrated technologies operating in sequence,
  - Each technology addresses a specific contaminant type of waste from the leachate

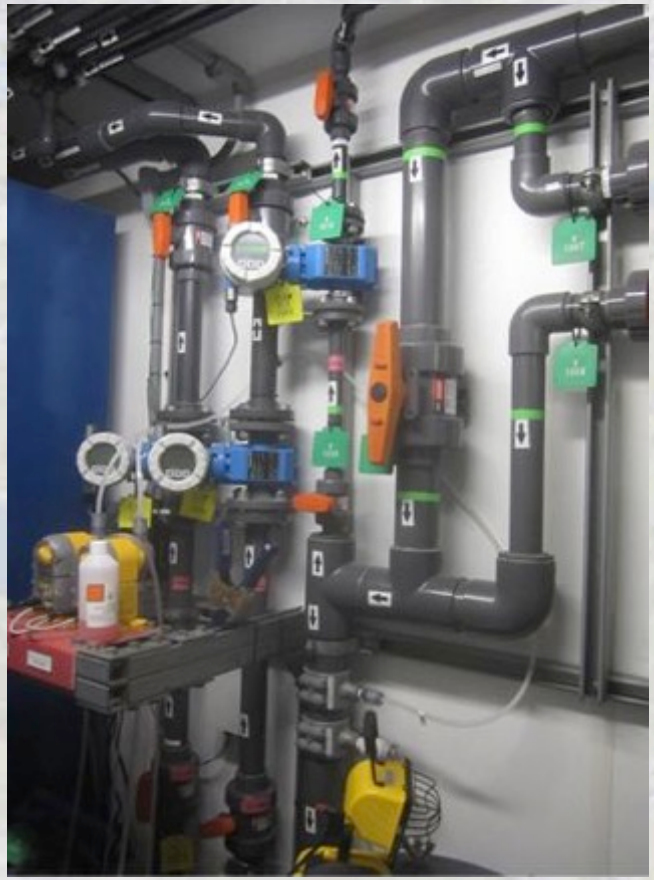


A high density sludge (HDS) process:

- Reduce heavy metal loading

Membrane bioreactor (MBR) process:

- Reduce organic and nitrogen loading



Two-stage reverse osmosis (RO) process:

- Reduce Boron loading and final polishing
- Meet the City's sewer bylaw discharge standards
- Meet surface water discharge limits

The City identified three objectives for the pilot plant:

Objective #1: To determine the treatment effectiveness of the pilot plant treating various BOD concentrations of raw leachate

Objective #2: To determine the effectiveness of each treatment processes

Objective #3: To identify potential uses for the partially and fully treated leachate

Fabrication and installation of the pilot plant:

- Dynatec Systems, Inc. was contracted by The City to fabricate a trailer-mounted pilot system
- CH2M coordinated and provided construction management for the pilot plant, and connection to an existing Tank Farm

Fabrication and installation of the pilot plant (continued):

- The three shipping containers, one for each of the treatment processes were installed next to an existing Tank Farm
- Supporting facilities: office, lab, and a chemical shed
- Pilot plant was commissioned in March of 2014
- City staff operate the pilot plant; CH2M providing operations support and technical advice

Fabrication and installation of the pilot plant (continued):

Leachate volume:

- Pilot plant's flow capacity: 10 L/min
- Daily volume of leachate treated by the pilot plant: 14 m^3
- Daily estimated volume of leachate generated at East Calgary WMF: 70 - 120 m^3
- There are 3 landfills in Calgary, with estimated daily leachate generation of: 250-300 m^3

Operation of the pilot plant:

Objective #1 –Determine the treatment effectiveness of the pilot plant treating raw leachate with various BOD concentrations:

- Testing pushed the plant's limits by "shocking" it
- In stress tests with very concentrated leachate (approximately BOD 3,000 mg/L), the plant failed due to limited dissolved oxygen

Objective #2 - Determine the effectiveness of each treatment processes:

Each of the three treatment processes addresses a specific treatment requirement:

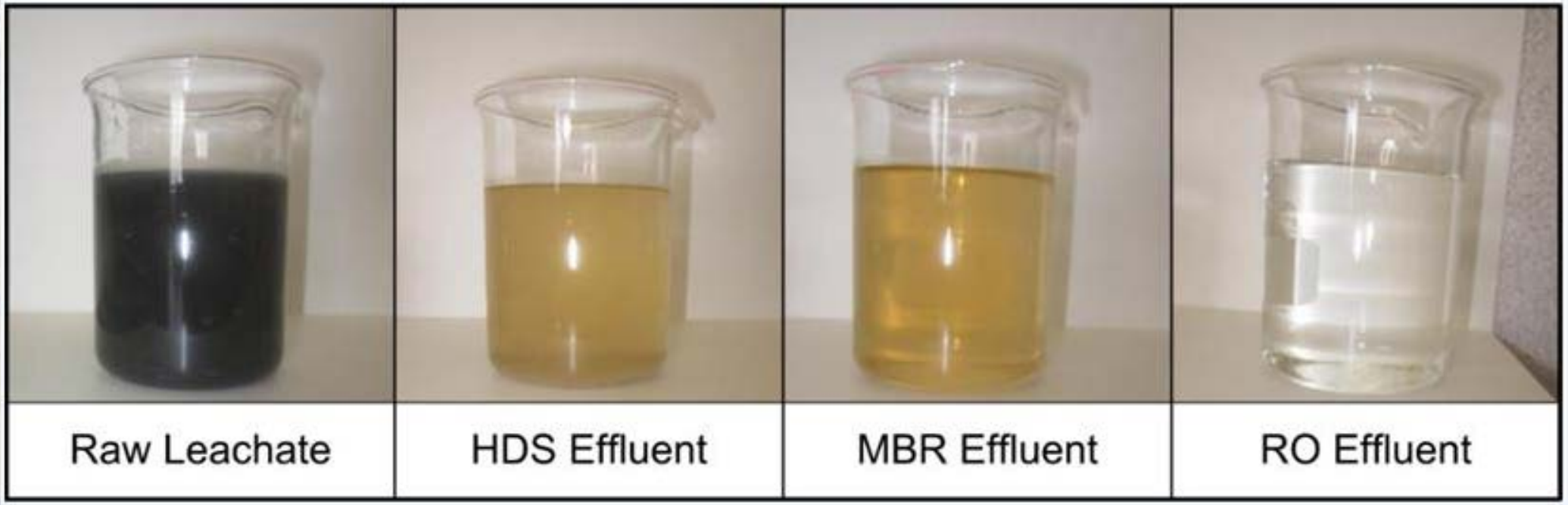
- HDS removes the heavy metals that have the potential of killing the micro-organisms used in the MBR process
- MBR removes the heavy organics and ammonia loading that is still in the leachate after the HDS treatment process
- RO reduces Boron and total dissolved solids (TDS), including lowering alkalinity

Objective #3: Identify potential uses for partially and fully treated leachate:

- Evaluate how to handle the waste generated from the processes and, at the same time, to determine how to put the process water – particularly the RO process effluent – into beneficial use
- Evaluate treated leachate in horticultural application

Treatment effectiveness:

- Effluent samples from each treatment process



Leachate treatment evaluation:

- Meet both sewer by-law and surface water discharge limits for all parameters:

  BOD, COD, Oil and Grease, $CaCO_3$, NH_3-N, Cl, F, NO_3-N, NO_3+NO_2-N, NO_2-N, P, SO_4, TKN, TN, TDS, TSS, Al, Sb, As, Be, Bi, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Zn

- Only exceeding in Hg concentrations by a very small margin

Key findings:

- Could treat leachate with BOD concentration up to 2,000 mg/L
- It is possible to treat the leachate to acceptable quality standards without the HDS process
- Raw leachate cannot be fed directly into the RO process, as it will foul the RO membranes
- Although the MBR effluent may be useable, the RO treated water quality is more versatile for re-use applications, such as process water or for irrigating plants

Meeting Objective #3 – using treated leachate as a resource:

A small (2.4 m x 9 m) horticultural greenhouse was constructed in spring of 2015 from recycled materials:

- Glass from the demolition of an old hockey rink, and old television glass screens
- Diverted waste wood from the landfill
- Discarded household sinks serve as containers for tree saplings

Greenhouse goal:

To evaluate how horticultural plants and tree nursery stock respond to the different qualities of treated leachate

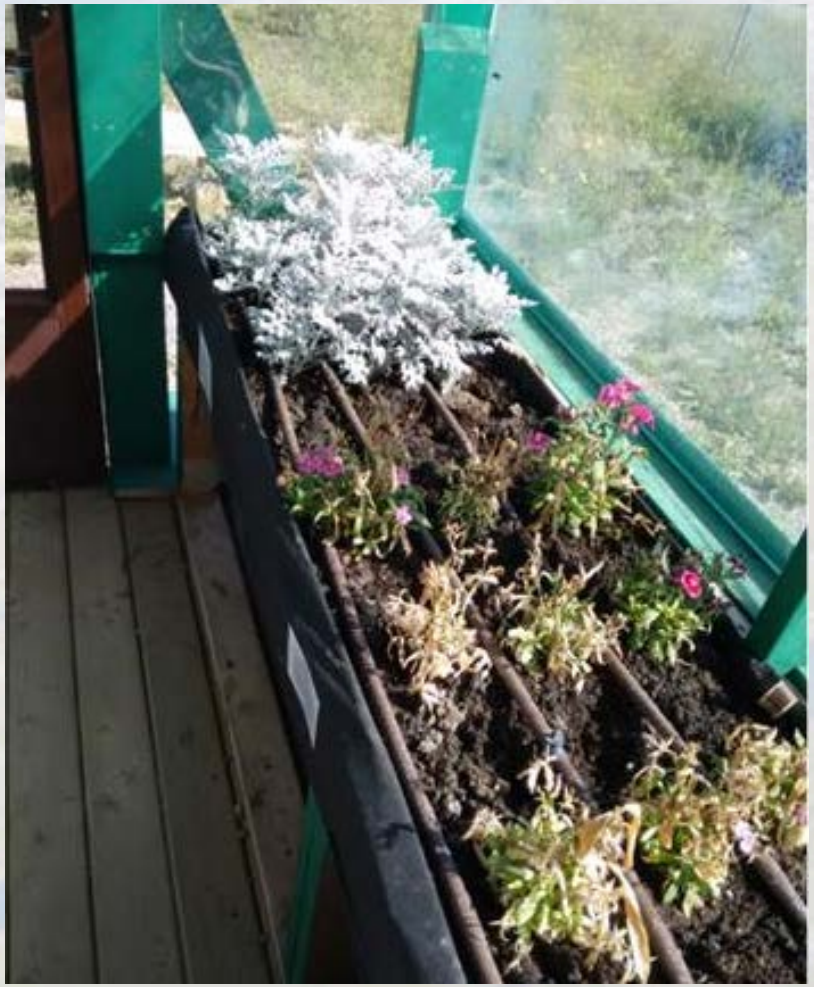
Plant selection:

- Drought, cold, heat, and/or salt tolerance,
- Native species and are typically grown or purchased by the City
- Included hardy dusty miller, begonias, petunias, pansies, and snapdragons

Greenhouse findings:

- Plants fed with HDS effluent water died
- HDS effluent contains high concentrations of heavy metals, organics, and ammonia

Greenhouse findings (continued):



- Plants fed with MBR effluent water survived but did not flourish
- MBR effluent contains high concentrations of TDS, as high as 7,000 mg/L, and an average alkalinity in the range of 3,000 mg/L

Greenhouse findings (continued):

- Plants fed with RO effluent flourished: TDS ~ 20 mg/L on average; alkalinity averaged 18 mg/L
- For the first year of greenhouse operation, the goal was meet by having it up and running and testing horticultural plants
- The plants provided a quick, visual gauge of our successes and failures with the various effluents

Greenhouse findings (continued):

Growing trees:

- Requires a longer-term commitment: the evergreen saplings now growing in salvaged kitchen sinks can be the key to the eventual greening of Calgary's landfills

How to utilize treated leachate during the cold winter months?

- Treated leachate can be stored outdoors, year-round, in lined storage ponds similar to stormwater ponds
- During the winter season, treated leachate from below the ice can be pumped into City greenhouses next to the landfill and put to good use – for example, to irrigate horticultural plants for spring planting by City Parks

Environmental value of the greenhouse project:

The greenhouse at the pilot plant has opened the door for exploring opportunities for using treated leachate as a potential resources. It may be one of the first facilities in Canada studying use of treated leachate by:

- Demonstrating how the treated leachate can be used for “greening up” the landfill
- Determining the level of treatment required to produce a useable effluent is cost effective by determining which treatment processes are required
- Identifying the species of plants and trees that will thrive on treated leachate water

Environmental value of the greenhouse project (continued):

- Promoting the use of innovative approaches to handle treated leachate
- Studying the use of treated leachate as a resource rather than a waste
- Reducing the use of The City's fresh water supply as process water
- Reducing the impact and costs to The City, including capital costs, utilities, and operating costs

Potential opportunities for the leachate pilot plant:

The pilot plant has the potential of achieving zero waste discharge from the landfill (both water and waste by-products from the treatment process):

- By eliminating the need to rely on municipal WWTPs to handle daily inflow from the landfill leachate, the overall pollution load on the WWTPs can be reduced
- Waste generated as a by-product of a pilot plant can be buried within the landfill
- Greening the landfill space will help to improve air quality and have a positive impact on Calgary's ecosystem, as well as attracting wildlife.

An invitation:

- Do you manage landfill leachate?
- Are you involved with leachate treatment?
- How do you handle treated leachate from your landfill?

Let's get the discourse going ….

Owrang Kashef, P.Eng.
CH2M, Calgary office, Alberta
Tel: 403-903-1798
Owrang.Kashef@CH2M.com